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Determination of Exhaust Emissions From 1971 Model Vehicles

Olson Labs, Inc, Dearborn, Mich

Prepared for

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SUMMARY

This document reports the exhaust emissions found in two-hundred-fifty 1971 model-year vehicles. The tests were conducted in Detroit, Michigan during the period March 5, 1971 through April 17, 1971. Measurements were made of carbon monoxide, unburned hydrocarbons, and oxides of nitrogen.

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SECTION I

INTRODUCTION

This program was conducted for the Environmental Protection Agency (EPA) during the period March 5, 1971 to April 17, 1971 to acquire the emission data that was required to implement provisions of recent legislation.[1] The program involved testing a cross-section of projected production of 1971 vehicles by the 1972 Federal test procedures to establish a nitrogen oxides (NO_x) emission baseline. Measurement of NO_x was accomplished utilizing the Chemiluminescence method as outlined in the proposed procedure.[2]

The program was conducted in four (4) phases. The first phase consisted of the construction and correlation of a Chemiluminescence instrument.[3] The second phase consisted of procurement of a representative sample of 1971 vehicles; the third phase, testing the vehicles; and fourth, the data reduction.

Emissions of hydrocarbons, carbon monoxide, carbon dioxide and nitrogen oxides were determined on a mass equivalent basis (grams per mile). The test results were then forwarded to EPA for further statistical analysis and evaluation.

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1 Public Law 91-604, "The Clean Air Act," December, 1970

2 Federal Register, Volume 36, No. 40, February 27, 1971

3 The particulars for the Chemiluminescence instrument reactor chamber design, flow schematic, and parts incorporated into the unit are included as Appendix E. The guide for construction and operation of the instrument was furnished by the project officer from EPA in an undated document entitled "Application of the NO/O_3 Chemiluminescent Reaction to Nitric Oxide Determination." Correlation of the instrument is discussed in Section 4.3, "Calibration and Correlation." The correlation data is presented in Appendix C.

SECTION 2

TEST VEHICLE PROCUREMENT

2.1 SELECTION OF 1971 CAR OWNER NAMES

Owner names were selected from Michigan State registration files of 1971 car purchasers for the months of September, October, and November. Initially all 1971 new car purchasers were taken from 25 Western Wayne County Zip codes which produced 6,013 owners consisting of 164 American Motors cars, 915 Chrysler Corporation cars, 3,847 Ford Motor Company cars, 666 General Motors cars and 421 Foreign cars. Because of the small supply of General Motors cars the survey was expanded to 22 additional Zip codes providing 5,043 additional names producing 315 more General Motors car owners and 4,728 making up the balance of all other makes. Only the names of General Motors car owners were used out of the second list because the response on all other makes of cars was more than adequate.

2.2 DIRECT MAIL MATERIAL

Three separate letters (see Appendix D) were prepared for mailing to each 1971 car owner. The letters were dated one week apart for progressive mailing. Each letter invited the car owner to help fight air pollution by having his car tested. Each letter contained a return-addressed, post-paid post card with which the owner could indicate his desire to participate in the test program. Also the letter provided a phone number for those people who preferred to respond by phone or who had some questions they wanted answered before consenting to have their car tested. The first letter was sent to 7,031 car owners and 833 follow-up letters were mailed to General Motors car owners for a total mailing of 7,864 pieces.

2.3 DIRECT MAIL RESPONSE

A total of 1,051 responses was recorded. 569 post cards were returned and 482 phone calls were taken. A Test

Vehicle Information (TVI) form was filled out for each response received and filed according to manufacturer and engine size. By the 19th of March 1971, 788 vehicles were tentatively qualified as test candidates providing a substantial pool for random selection and test scheduling. The distribution of these vehicles by manufacturer was as follows:

Manufacturer	Test Required	Available Vehicles
American Motors	12	25
Chrysler Corporation	73	108
Ford Motor Company	92	504
General Motors	61	148
Foreign	12	3
Totals	250	788

Test cars were then chosen at random from this file in quantities prescribed by the test profile supplied by the government and shown on Table I[4].

2.4 DISTRIBUTION OF TEST SAMPLE

The cars tested were randomly selected 1971-model light-duty vehicles which had accumulated 4,000 or more miles of operation. Ninety-seven 50-state vehicles and 190 non-50-state vehicles were tested. Fifty-state vehicles are defined as those vehicle types which comply with the California emission standard for oxides of nitrogen and, therefore, can legally be sold in all 50 states of the United States. Non-50-state vehicles are defined as those vehicles which cannot be sold in the State of California because they are not designed to comply with the California emission standard for oxides of nitrogen. Twenty test cars had the additional requirement that ten be equipped with crankcase evaporative emissions storage

4 Cf. post, page 12.

systems and ten be equipped with canister-type evaporative emissions storage systems. The number of each engine size and make tested is shown on Table 1[5]. The actual types of vehicles tested represent, as closely as possible, the government estimated population of 1971 vehicles.

[5] cf post, page 12.

SECTION 3

TEST VEHICLE PREPARATION

3.1 TUNE-UP PROCEDURE

Prior to the testing soak period, each vehicle was inspected and set to manufacturer's recommended specification. Parameters used were; ignition cam dwell, idle RPM and basic timing. The automatic choke operation was checked and spark plugs were replaced if misfire was detected. The idle mixture was set to specification by manufacturer's recommended procedures.

In cases where carburators or other parts of the emission equipmunt were known or found to be tampered with (except for idle limiters), the vehicle was rejected. Of the vehicles inspected, one percent were rejected for the stated reason.

After the tune-up, the vehicle was soaked for a minimum of 12 hours, prior to testing.

3.2 EVAPORATIVE EMISSION PRE-CONDITIONING PROCEDURE

After completion of the first cold start test procedure on 20 of the vehicles, the vehicles were pre-conditioned and tested in the following manner:

a. The test vehicle was operated on the road for one hour on the 32 mile route. The route was modified as shown in Figure 1[6] to simulate as closely as possible the route described in the Federal Register.[7]

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[6] Cf post, page 11

[7] Federal Register, Volume 35, Number 219, November 10,1970, paragraph 85.83a.

b. The fuel tank was drained and Indolene 30 fuel was added.[8]

c. The test vehicle was placed on the dynamometer and operated over a simulated trip according to the applicable requirements and procedures of the Federal Register.[9]

d. The vehicle was allowed to soak inside the test facility for a minimum of 11 hours as described in Federal Register.[10]

e. The fuel tank was then drained and charged to 40 percent of capacity with Indolene 30 from a fuel conditioning cart. The fuel tank thermocouple was omitted as no recording of the fuel tank temperature was required.[11]

f. Immediately following the fuel change, the exhaust pipe(s) and inlet pipe to the air cleaner were sealed. A heating blanket was applied to the tank to heat the fuel for one hour to the specified temperature.[12,13] A canister vapor collection system was not installed as the actual measurement of fuel evaporative emissions was not required.[14]

g. Immediately following the heating of the fuel in the tank, the vehicle was placed on the dynamometer and tested for exhaust emissions.

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8 Ibid, paragraph 85.73b.

9 Ibid, paragraph 85.73c.

10 op cit, Federal Register, Volume 35, para 85.73d and 85.74a.

11 Environmental Protection Agency, Contract 68-04-0003, Supplemental Agreement 3A, April 21, 1971.

12 A preliminary test was run using 8 gallons of fuel in a 20 gallon tank, a thermocouple was installed in the tank and a 1150 watt heating blanket was set with a Variac at 80% of line voltage. This raised the temperature from 60° to 84°F in one hour as prescribed in the Federal Register. This same setting was used for all vehicles.

13 op cit, Federal Register, Volume 35, para 85.74a.

14 op cit, EPA, Contract 68-04-0008.

SECTION 4

TESTING PROCEDURE

4.1 GENERAL

Test procedures used conformed to those stipulated in 35 Federal Register 219, Part II, November 10, 1970, Section 85.70 and 85.87 inclusive. Except for the last 20 vehicles, those sections pertaining to the fuel evaporative losses were excluded. See Section 3.2 for a description of the additional test procedure used for these vehicles. Measurements of carbon monoxide (CO), carbon dioxide (CO_2) and hydrocarbons (HC), were made. The method used for NO_x is described in the proposed procedure.[15]

4.2 EQUIPMENT DESCRIPTION

The following is an outline of the equipment and instruments used.

a. Clayton Model EC-200 Variable Inertia Dynamometer with 250-pound increment loading weights.

b. Olson Model 45D-R3 Constant Volume Sampler with a dilution air filtering system, stainless steel heat exchanger, temperature control and solenoid operated bag sampling system. The sampler meets the requirements stipulated in the Federal Register.[16]

c. Sample conditioning and analytical system consisting of:

Beckman Model 315 NDIR analysers with these ranges:

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15 op cit, Federal Register, Volume 36

16 op cit, Federal Register, Volume 35, Part II,

Carbon Monoxide 0-0.3 percent
Carbon Dioxide 0-4.0 percent

Beckman Model 400 Flame Ionisation Analyser with the following full scale ranges:

Hydrocarbons 0-100
Hydrocarbons 0-500

d. Nitrogen Oxides (NO_x) analyser of the Chemiluminescence type constructed by O.I in accordance with specifications supplied by the Air Pollution Control office (APCO) of the Environmental Protection Agency. A thermal converter was used for conversion of NO_2 to NO.

e. NO_x analyser of the Chemiluminescence type constructed by APCO (Fairfax 001) also utilising a thermal converter.

f. Drivers Aid:

Varian Model G-1000 using preprinted paper supplied by Educational Reading Aids and Varian Chart #71-000200-00.

g. A Hartzell Model N24 - 0UW fan supplied cooling air to the front of the vehicle.

h. A Honeywell temperature recorder with an IC thermocouple for recording blower inlet temperature.

4.3 CALIBRATION AND CORRELATION

The Constant Volume Sampler (CVS) was calibrated by EPA personnel and equipment. A Meriam Laminar flow element was used to measure the air flow to the inlet of the blower. Incremental changes in inlet depression were simulated using a throttling valve. Calibration of the sampler was repeated near the end of the program. The two calibrations agreed within 1% in the operating range of the sampler (61-64 MM.Hg). The calibration data appears in Appendix A.

The calibration was checked by metering known amounts (by differential weighing) of propane into the sampler.

The calculated value was based on the first calibration and agreed within approximately 1% of the actual weight of propane (Appendix A).

The dynamometer was calibrated using the method outlined in the Clayton Manual. The calibration was checked at the end of the testing program and no significant change in the calibration was found.

Calibration curves for the analysers were prepared using calibration gases analyzed by APCO. Each analyser was calibrated with four known standards and zero in the specified ranges. Calibration standards are listed in Appendix B.

Span gases used for routine calibration of the instrument were either analysed by APCO or from standards analysed by APCO.

The gases for the Chemiluminescence instrument were analysed by APCO by several different instruments. Included with the nitric oxide (NO) gases were a few nitrogen dioxide (NO_2) gas mixtures which were used to determine the thermal converter efficiency. Reasonable correlation between the two instruments was obtained. The analyses of these cylinders by the various instruments is presented in Appendix C.

SECTION 5

TEST RESULTS

The test results are presented in Table 2.[17] The table gives Car No.; Vehicle Identification No. (VID); Cold Start, Replicate or Evaporative (C, R, E); and final calculated mass emissions in grams per mile for hydrocarbon (HC), carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO), and nitric oxide (NO) corrected for humidity. Oxides of nitrogen is reported as NO_2 both as measured and as corrected for humidity. In the data tables the concentrations obtained from the Olson instrument are presented first under the column (NO*)gm/mi and the APCO instrument under the second column (NO**)gm/mi.

A description of the test vehicles can be obtained from Table 1.[18] Additional vehicle information and test data such as calibration, license number, ambient conditions, dynamometer settings, and emission data on a volumetric basis are recorded on punch cards.

The ninety-seven 50-state vehicle tests consisted of 81 cold starts, nine replicates, and seven evaporative pre-conditioning procedure tests (Para. 3.2).

The 190 non-50-state vehicle tests consisted of 164 cold starts, 13 replicates, and 13 evaporative pre-conditioning procedure tests.

The above combine for a total of 245 cold starts, 22 replicates, and 20 evaporative pre-conditioning procedure tests; for a grand total of 287 tests.

At conclusion of testing and calculations for mass equivalent emissions values, all data were forwarded to the Environmental Agency for further statistical analysis and evaluations. The results of those analysis and evaluations were beyond the scope of this study.

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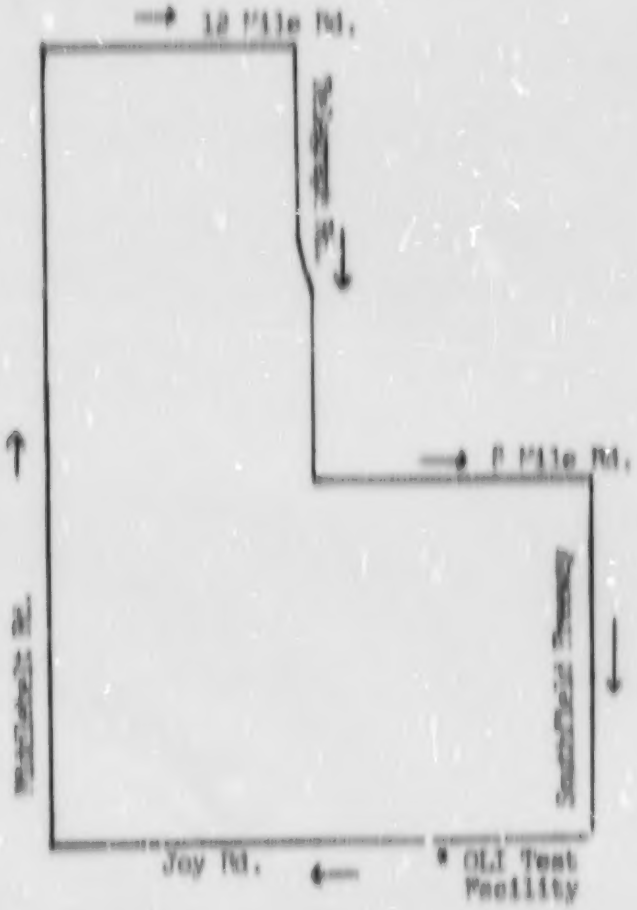
17 Cf post, page 14.

18 Cf post, page 12.

FIGURE 1

Simulated Mileage Accumulation Route used for Evaporative Emission Pre-Conditioning.



Total Miles = 32

Driving Time = 1 hr.

TABLE 1

DISTRIBUTION OF CARS TESTED

VID	MAKE	CID	TRANS REQ.	TESTS PERFORMED					
				50-STATE VEHICLES			NON 50-STATE VEHICLES		
				C*	R*	E*	C	R	E
1	Chevrolet	350	13	18	0	0			
2	Ford-MT	351	0				0	0	0
3	Ford-AT	351	31				35	2	2
4	Chevrolet	307	6	2	2	2			
5	Volkswagen	97	6	2	0	0			
6	Chrysler	360	16				17	0	0
7	Chrysler-Hi PER	383	2	2	1	0			
8	Ford	302	6	5	1	1			
9	Chevrolet	350	6	4	0	0			
10	Oldsmobile	455	5	5	1	1			
11	Chrysler	318	22				22	1	1
12	Buick	350	5	5	1	0			
13	Oldsmobile	350	4	2	0	1			
14	Buick	455	4	2	1	0			
15	Pontiac	400	4	3	0	1			
16	Pontiac	350	3	3	0	0			
17	Ford	400	13				16	1	0
18	Ford	429	12				12	2	0
19	Ford Hi PER	429	0						
20	Chrysler	225	11				11	0	1
21	Chevrolet	140	2	2	0	0			
22	Chrysler	360	10				9	1	1
23	Ford-MT	122	1	0	0	0			
24	Ford-AT	122	6				7	2	0
25	Chevrolet	400	2	4	0	1			
26	Cadillac	472	2	2	0	0			
27	Pontiac	455	2	2	0	0			
28	Chrysler	440	6				6	0	0
29	Chrysler-Hi PER	440	0						
30	AMC	232	7				6	0	1
31	Chevrolet	402	2	1	0	0			
32	Datsun	97	2	0	0	0			
33	Toyota	113	2	1	0	0			
34	Ford-MT	360	0						
35	Ford-AT	360	3				1	0	0
36	Ford	250	8				4	0	1
37	Opel	116	1	0	0	0			
38	Ford	200	4				4	0	0
39	Ford	240	4				0	0	0
40	Chevrolet	454	1	1	0	0			
41	AMC-MT	304	0						
42	AMC-AT	304	1	1	2	0			
43	Ford-MT	390	0						
44	Ford-AT	390	3				1	1	0
45	Chrysler	198	3				1	0	0
46	Ford	460	2				1	1	0
47	AMC	360	2				2	0	1

* C = Cold Start
* R = Replicate Test
* E = Evaporative Preconditioned Test

TABLE 1 (Cont.)

DISTRIBUTION OF CARS TESTED

VID	MAKE	CID	TEST FAM.	TESTS PERFORMED					
				50-STATE VEHICLES			NON 50-STATE VEHICLES		
				C*	R*	E*	C	R	E
48	Toyota	71	1	1	0	0			
49	Ford-MT	98	1				1	0	0
50	AMC	258	2				1	0	1
51	Toyota	97	0						
52	VW	103	6						
53	Audi	100	0						
54	BLM	78	0						
55	Volvo	121	0						
56	Ford (Import)	98	0						
57	Ford-MT (Bronco)	170	0						
58	Ford-Others	170	1				1	0	0
59	Chrysler	340	1				1	0	0
60	Fiat	55	0						
61	Cadillac	500	0						
62	Mitsubishi	98	0						
63	Datsun	72	0						
64	Mercedes	170	0						
65	Others	0	0						
66	Others	0	0						
	Total	250		81	9	7	164	13	13

RECAPITULATION

	C	R	E	Totals
50-State Vehicles	81	9	7	97
Non 50-State Vehicles	164	13	13	190
Totals	245	22	20	287

C = Cold Start
R = Replicate Test
E = Evaporative Preconditioned Test

TABLE 2

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	CODE REP	HC MASS GM/MI	CO MASS GM/MI	CO2 MASS GM/MI	NO * MASS GM/MI	NO ** MASS GM/MI	NO * HUM GM/MI	NO ** HUM GM/MI
430017	35	C	2.48	31.36	357.80	1.07		0.88	
430018	6	C	4.01	42.37	781.17	4.17		3.67	
430019	47	C	4.00	49.48	602.16	4.03		3.38	
430020	20	C	2.17	32.89	468.05	3.74		3.08	
430021	29	C	3.60	66.15	736.49	3.71		3.11	
430022	40	C	2.70	42.75	387.50	2.70		2.36	
430023	11	C	2.28	31.53	203.08	1.46		1.19	
430024	6	C	4.15	69.67	584.89	3.73		3.07	
430026	6	C	4.70	65.30	665.28	3.37		2.81	
430027	11	C	3.90		554.00	3.06		2.68	
430025	11	C	3.52	46.53	272.77	1.87		1.53	
430028	11	C	3.47	30.25	607.74	4.17		3.72	
430029	29	C	2.95	10.79	636.13	5.00		4.35	
430030	11	C	4.00	51.80	297.43	2.07		1.86	
430031	6	C	3.22	34.97	640.60	5.37		4.37	
430032	42	C	4.10	42.06	604.14	2.78		2.38	
430033	22	C	4.10	53.40	699.09	4.47		3.69	
430034	29	C	4.01	58.97	652.63	2.03		1.81	
430035	11	C	5.00	74.54	615.12	1.08		0.97	
430036	6	C	6.00	90.91	657.41	0.77		0.63	
430037	28	C	3.02	59.28	749.75	3.45		3.11	
430038	28	C	2.93	38.92	631.11	3.01		2.56	
430039	28	C	3.30	65.43	799.00	2.59		2.19	
430040	11	C	4.27	32.02	732.26	4.54		3.81	
430041	11	C	4.99	61.59	640.37	1.88		1.57	
430042	6	C	2.02	35.56	350.65	1.42		1.21	
430043	3	C	3.39	44.91	564.57	1.50		1.27	
430044	3	C	3.74	30.72	734.75	6.30		5.70	
430045	3	C	4.16	53.77	647.55	1.13		0.99	
430047	3	C	4.32	64.52	755.97	3.93		3.50	
430049	3	C	4.07	67.81	671.08	4.81		4.09	
430015	20	C	3.36	47.84	383.09	2.43		2.01	
430002	42	C	2.74	30.13	676.92	1.85		1.55	
430002	42	R	3.55	47.61	719.58	3.45		2.96	
430003	42	C	2.64	31.63	599.13	3.45		3.00	
430003	42	R	3.72	39.88	654.92	3.27		2.80	
430004	11	C	3.27	41.86	544.58	4.57		3.93	
430004	11	R	3.59	45.80	578.41	4.31		3.69	
430005	11	C	2.65	45.29	550.24	4.14		3.59	
430005	11	R	3.37	57.33	639.15	3.35		2.78	
430006	11	C	3.15	39.04	731.15	5.52		4.68	
430007	11	C	2.31	29.79	632.89	2.57		2.19	
430007	11	R	2.55	33.32	641.83	2.39		2.06	
430008	3	C	3.04	39.76	690.41	4.17		3.65	
430008	3	R	3.08	39.59	765.14	4.30		3.73	
430009	3	C	3.78	46.59	616.09	4.10		3.40	
430009	3	R	3.19	48.91	667.23	4.43		3.80	

* CLI CL Instrument
** EPA Fairfax 001 CL Instrument

TABLE 2

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	COLD REP	HC MASS GM/ MI	CO MASS GM/MI	CO2 MASS GM/MI	NO* MASS GM/MI	NO** MASS GM/MI	NO* HUM GM/MI	NO** HUM GM/MI
430010	22	C	5.94	23.28	689.40	5.76		4.97	
430010	22	R	5.26	17.99	644.97	5.97		5.15	
430011	30	C	3.54	16.25	440.56	3.88		3.42	
430012	20	C	3.85	32.73	372.50	3.07		2.61	
430013	20	C	5.63	56.84	437.28	4.12		3.47	
430014	59	C	4.17	65.94	231.05	2.30		1.90	
430050	3	C	4.42	51.67	670.66	3.53		3.01	
430051	3	C	3.58	30.37	641.96	3.26		2.96	
430052	3	C	3.06	30.46	719.78	3.00		2.44	
430053	11	C	4.32	72.01	539.66	3.10		2.70	
430054	11	C	3.88	70.62	400.50	3.34		2.77	
430055	3	C	5.75	81.86	605.49	4.61		4.02	
430059	11	C	4.20	60.31	593.40	3.66		3.29	
430060	17	C	4.17	62.96	812.16	6.65		6.21	
430061	17	C	5.73	31.03	798.60	7.38		6.84	
430062	18	C	5.00	41.86	744.77	6.75		6.12	
430062	18	R	5.69	32.71	676.91	6.25		5.48	
430063	3	C	5.35	32.83	679.12	5.08		4.14	
430064	3	C	5.74	63.66	713.70	4.96		4.35	
430065	17	C	4.25	56.64	835.63	8.02		6.94	
430066	3	C	3.89	42.59	740.42	5.98		5.20	
430067	17	C	4.15	45.52	830.00	6.55		5.38	
430068	18	C	4.59	46.13	878.27	7.00		5.78	
430069	17	C	5.20	73.08	786.64	4.71		4.34	
430070	3	C	3.94	36.76	678.65	5.16		4.87	
430071	18	C	5.46	85.20	815.60	6.03		5.02	
430072	30	C	3.30	29.86	401.17	2.35		1.99	
430073	17	C	4.29	62.05	770.06	3.60		3.30	
430074	3	C	3.96	42.78	699.67	5.05		4.53	
430075	3	C	4.20	42.94	717.98	6.63		2.61	
430076	18	C	4.23	31.89	841.66	7.83		6.92	
430077	30	C	3.23	40.38	440.49	5.63		4.51	
430078	11	C	2.89	26.34	598.07	3.71		3.21	
430079	18	C	3.26	31.08	705.54	4.96		3.80	
430080	24	C	4.23	46.75	340.10	6.49		5.47	
430081	11	C	4.16	53.31	567.34	4.05		3.28	
430082	18	C	4.87	33.56	900.65	7.41		6.55	
430083	18	C	3.69	34.27	402.79	4.11		3.37	
430084	36	C	5.07	23.11	474.16	6.92		5.45	
430085	24	C	3.04	39.73	349.95	5.07		4.20	
430086	38	C	5.49	21.36	423.64	5.66		4.76	
430087	17	C	3.86	65.78	633.74	4.28		3.68	
430089	44	C	4.70	91.02	708.78	5.11		4.40	
430090	1	C	3.83	35.76	603.87	3.16		2.60	
430091	1	C	3.01	37.71	627.14	3.88		2.35	
430092	1	C	2.87	35.96	645.60	3.42		2.82	
430093	36	C	4.08	72.46	493.08	6.31		4.49	
430094	1	C	4.97	56.78	542.48	3.21		2.74	

* CLI CL Instrument
** RCA Fairfax 001 CL Instrument

TABLE 2

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	CODE REP	HC MASS GM/MI	CO MASS GM/MI	CO2 MASS GM/MI	NO * MASS GM/MI	NO** MASS GM/MI	NO* HUM GM/MI	NO ** HUM GM/MI
430095	20	0	1.53	41.58	424.97	5.07		4.19	
430096	30	0	2.32	23.69	451.63	3.48	2.91	2.86	2.48
430097	24	0	2.07	37.62	340.11	5.72		4.72	
430098	1	0	2.93	36.21	677.78	4.27		3.45	
430099	1	0	1.48	20.62	625.33	3.42		2.79	
430100	58	0	1.09	10.47	360.10	1.71		1.01	
430101	1	0	3.47	51.49	781.65	4.04		3.25	
430102	4	0	3.11	18.09	573.88	3.55	2.85	3.00	2.43
430103	1	0	2.46	28.20	566.18	2.63		2.29	
430108	9	0	2.74	40.21	640.39	3.54	2.79	3.02	2.37
430106	21	0	1.79	28.66	318.13	4.42		3.65	
430107	31	0	2.31	35.30	775.02	2.43		1.94	
430108	1	0	3.36	52.02	711.51	3.13	2.64	2.65	2.21
430109	46	0	2.23	12.44	870.60	4.85		4.20	
430110	9	0	2.83	30.82	604.07	3.51		3.00	
430111	21	0	1.90	39.82	254.76	2.91		2.40	
430112	4	0	3.23	31.72	582.64	4.48		3.50	
430113	25	0	3.14	84.01	688.72	2.32		2.02	
430114	1	0	3.68	60.28	663.81	1.92		1.78	
430115	27	0	4.99	94.12	623.36		1.91		1.55
430116	13	0	7.19	42.04	852.52		4.61		3.93
430117	18	0	3.68	27.71	829.25		5.39		4.38
430118	16	0	3.11	25.07	843.46		4.84		3.96
430121	13	0	4.73	43.67	675.88		8.19		6.60
430122	14	0	4.09	74.75	831.09		6.66		5.41
430123	5	0	3.23	62.63	303.20		2.42		2.02
430124	12	0	4.06	83.77	792.63		1.99		1.32
430125	27	0	7.49	97.97	797.35		3.97		3.10
430126	8	0	6.14	68.75	679.52		3.01		2.43
430127	10	0	8.23	91.04	669.74		6.69		4.80
430128	6	0	2.65	33.38	533.38		1.01		1.58
430126	6	R	2.77	37.37	477.16		1.44		1.24
430129	10	0	8.25	99.92	706.75		4.78		3.87
430130	8	0	4.78	70.52	482.12		1.97		1.66
430132	16	0	3.22	52.65	600.83		2.21		1.80
430134	5	0	2.39	41.74	352.39		1.39		1.18
430135	5	0	1.63	37.26	251.16		1.54		1.26
430136	20	0	1.25	40.33	409.70		1.90		1.50
430137	13	0	3.40	27.50	548.84		2.26		1.89
430138	5	0	2.58	50.93	365.73		1.38		1.12
430139	11	0	2.37	52.50	519.16		1.64		1.37
430140	2	0	2.05	64.97	237.77		1.39		1.15
430141	2	0	2.62	31.05	552.26		2.38		2.00
430142	25	0	3.10	63.95	604.25		3.80		3.03
430143	3	0	4.23	46.92	577.00		4.33		3.41
430144	5	0	2.87	45.15	631.50		6.60		6.17
430145	1	0	3.86	68.70	735.49		4.78		3.96

* GLI CL Instrument
** EPA Fairfax 001 CL Instrument

TABLE 8

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	COLD PREP	HC MASS GM/MI	CO MASS GM/MI	CO2 MASS GM/MI	NO* MASS GM/MI	NO** MASS GM/MI	NO* HUM GM/MI	NO** HUM GM/MI
430146	44	C	3.91	70.12	718.07				
430147	10	C	2.44	47.77	770.81		5.76		4.72
430147	10	R	2.14	31.69	756.05		5.69		4.82
430148	6	C	1.99	50.16	647.45		5.46		4.60
430149	15	C	1.16	28.57	826.61	6.72		5.54	
430150	9	C	2.04	30.69	767.10		4.13		3.34
430151	12	C	4.44	63.03	776.04	2.51	2.42	2.06	1.98
430151	12	R	3.07	46.32	681.80	3.75	4.85	3.16	4.08
430152	19	C	1.66	34.33	720.00	4.40	4.64	3.66	3.64
430154	9	C	2.53	31.55	705.27	3.85	3.68	3.02	2.82
430155	11	C	2.05	33.74	642.21	2.79	3.07	2.30	2.54
430156	11	C	1.44	20.25	616.03	3.59	3.34	3.02	2.81
430157	11	C	1.52	21.73	524.84	2.61	2.71	4.60	4.68
430158	18	C	1.61	26.75	698.00	3.57	3.50	2.13	2.07
430159	4	C	4.55	29.34	546.81	3.07	3.02	3.31	3.28
430160	7	C	3.76	27.69	709.26	3.73	3.83	3.00	3.17
430161	6	C	4.42	26.76	697.24	3.12	3.16	3.00	3.00
430164	33	C	2.81	52.53	824.64	4.13	4.93	4.47	4.15
430165	16	C	1.76	30.48	243.10	1.89	1.70	1.52	1.40
430166	8	C	3.67	42.42	577.61	4.89	4.79	3.92	3.80
430167	7	C	4.32	62.08	776.91	3.33	3.47	2.70	2.82
430167	7	R	4.15	60.22	741.73	2.67	3.06	2.12	3.14
430168	20	C	3.19	57.21	373.94	1.20	1.17	2.20	1.52
430169	46	C	3.63	59.26	781.49	4.68	4.78	3.87	3.92
430170	46	C	3.71	46.77	765.26	4.86	6.05	4.02	4.99
430171	16	C	3.77	45.35	647.77	4.02	3.16	3.34	2.62
430173	4	C	3.42	11.17	580.27	3.79		3.07	
430174	46	C	2.79	14.14	820.61	5.07	4.98	4.11	4.03
430175	15	C	5.56	85.46	749.12	6.03	6.27	5.22	5.01
430176	40	C	3.25	49.01	261.97	2.29	3.30	1.86	2.28
430177	4	C	2.88	9.01	523.23	2.59	2.64	2.18	2.22
430178	14	C	2.65	27.33	803.40	4.29	4.48	3.33	3.48
430178	14	R	2.87	36.64	856.86	4.47	4.80	4.00	4.20
430179	30	C	2.97	56.08	263.94	1.09	2.33	4.34	4.54
430180	1	C	2.34	19.56	606.27	3.01	2.47	1.71	2.22
430181	1	C	4.27	71.13	599.31	3.90	3.20	2.74	2.92
430182	17	C	4.76	92.18	720.68	2.74	4.13	2.66	2.88
430183	3	C	3.62	38.63	728.40	4.67	4.18	2.36	3.63
430184	13	C	5.20	82.66	773.31	3.76	5.09	4.21	4.70
430185	17	C	2.62	37.23	730.56	3.41	4.23	2.07	3.24
430186	4	C	4.02	14.87	588.92	4.09	3.70	3.33	3.61
430186	4	R	4.18	13.61	589.66	4.01	4.09	3.75	3.75
430187	17	C	4.15	71.63	734.19	6.22	4.20	3.62	3.79
430187	17	R	3.51	98.21	693.48	4.14	7.25	5.75	6.62
430188	3	C	3.24	50.09	679.26	3.30	5.29	3.16	4.30
430189	1	C	3.28	37.01	611.82	3.13	4.12	4.25	4.03
430190	46	C	2.74	63.26	661.55	3.62	3.51	2.71	3.04
430191	46	R	2.23	36.87	752.41	5.06	4.13	3.15	3.59
430191	46	R					5.45	4.59	4.92

* CLI CL Instrument
** EMA Beckman 801 CL Instrument

TABLE 8

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	(COLD) REP	HC MASS GM/MI	CO MASS GM/MI	CO2 MASS GM/MI	NO * MASS GM/MI	NOX * MASS GM/MI	NO * HLM GM/MI	NO ** HLM GM/MI
430198	17	C	4.01	55.42	634.42	5.05	6.87	5.36	6.10
430193	1	C	4.36	58.75	662.35	5.48	6.80	4.44	4.86
430194	3	C	3.59	48.68	722.03	6.31	6.36	5.11	5.15
430192	35	C	4.41	59.20	731.59	5.93	6.98	4.87	4.91
430196	4	C	2.24	10.33	296.44	2.38	2.63	2.12	2.16
430190	4	R	4.25	19.38	626.72	4.07	4.78	4.31	4.72
430197	3	C	4.34	31.96	635.14	2.36	6.20	4.64	5.35
430198	3	C	4.79	32.42	644.84	2.36	6.41	6.07	6.12
430199	44	C	4.27	87.38	719.25	4.84	5.17	4.06	4.33
430199	44	R	5.99	101.14	815.90		6.79		5.95
430200	24	C	3.46	40.44	447.91	3.64	5.11	3.99	4.20
430200	24	R	3.35	46.24	471.66		5.58		4.47
430201	17	C	3.50	52.23	602.36		6.71		5.07
430202	18	C	7.06	85.04	846.56		6.56		6.14
430203	3	C	4.14	49.77	711.37		3.72		3.00
430204	18	C	5.21	47.45	824.06		8.21		7.26
430205	18	C	1.89	35.75	1077.01		5.06		5.03
430206	17	C	4.92	71.13	730.04		7.28		6.68
430207	18	C	5.11	84.27	723.70		6.68		5.88
430207	18	R	6.23	84.67	902.12		11.62		9.75
430208	24	C	3.79	49.73	356.99		7.83		6.35
430208	24	R	3.65	40.22	320.79		5.18		4.45
430209	1	C	3.48	33.47	720.60		5.99		4.87
430210	17	C	6.07	40.75	685.81		3.66		3.22
430211	26	C	1.59	54.80	1084.94		4.44		4.04
430212	3	C	5.25	47.40	725.71		9.35		7.35
430213	3	C	3.08	60.63	683.40		6.36		5.62
430214	3	C	3.74	47.58	649.32		4.58		3.68
430215	36	C	3.41	31.14	562.62		8.29		7.71
430216	3	C	4.32	63.27	688.14		5.03		4.50
430217	3	C	5.50	79.56	671.74		7.82		7.24
430218	3	C	4.55	53.42	692.48		4.83		4.12
430219	12	C	2.97	58.80	844.82		5.01		4.17
430219	12	R	2.94	61.71	842.85		4.72		3.88
430220	6	C	4.02	47.03	667.16		6.40		5.75
430222	6	C	2.00	51.20	669.18		4.91		4.04
430223	6	C	4.25	46.04	899.24		8.62		7.48
430224	6	C	4.14	71.72	708.91		5.10		4.15
430225	6	C	5.42	49.76	694.61		5.82		4.96
430226	22	C	4.03	62.97	645.75		6.30		5.28
430227	17	C	4.11	58.98	734.78		4.30		3.57
430228	6	C	3.91	60.78	636.59		6.32		5.07
430229	28	C	4.68	88.96	665.51		4.75		3.77
430230	6	C	4.26	61.33	715.79		6.82		5.69
430232	28	C	3.17	35.94	727.20		6.06		5.04
430233	6	C	4.89	87.78	594.29		3.85		3.20

* CLI CL Instrument

** RPA Fairfax 001 CL Instrument

TABLE 2

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	COLD HOT EVAP	HC MASS GM/MI	CO MASS GM/MI	CO2 MASS GM/MI	NO * MASS GM/MI	NO ** MASS GM/MI	NO* HUM GM/MI	NO** HUM GM/MI
430237	25	C	2.54	11.26	859.90		3.35		3.09
430238	26	C	1.53	42.01	816.73		5.47		6.16
430239	48	C	1.61	40.51	316.79		2.27		1.95
430237	11	C	1.41	29.26	649.05		4.26		3.50
430238	6	C	6.54	100.49	725.63		2.04		1.63
430240	12	C	2.21	57.27	689.66		2.88		2.43
430241	24	C	1.94	52.74	309.86		2.08		1.73
430242	20	C	3.15	37.50	413.10		4.81		3.91
430243	38	C	1.04	33.42	439.43		4.82		4.06
430244	24	C	3.99	45.54	329.72		3.05		2.80
430245	26	C	2.50	39.50	399.31		4.86		4.20
430252	20	C	2.88	25.00	383.49		3.63		3.01
430252	20	E	1.81	26.07	294.73		2.87		2.41
430246	47	C	2.40	33.78	618.01		2.99		2.65
430246	47	E	4.20	34.91	663.46		4.63		4.26
430249	8	C	4.00	41.67	537.53		3.23		2.83
430249	8	E	4.46	44.09	533.18		2.71		2.29
430259	20	C	2.93	63.53	392.86		4.69		4.33
430259	20	E	3.53	73.76	425.52		2.16		1.77
430247	10	C	2.54	30.37	809.03		2.90		2.65
430247	10	E	1.66	21.61	978.56		3.69		3.08
430250	30	C	2.98	59.69	481.81		3.29		3.39
430250	30	E	3.23	43.17	478.11		3.40		2.63
430253	13	C	3.70	74.50	593.83		3.45		2.83
430253	13	E	3.49	74.47	633.86		4.21		3.56
430248	30	C	3.28	66.11	398.02		5.26		5.31
430248	30	E	3.34	62.47	403.09		5.64		4.65
430254	36	C	2.72	43.91	416.74		4.89		4.09
430254	36	E	3.40	51.11	438.66		5.18		4.07
430255	19	C	4.17	48.04	526.42		5.56		4.89
430255	19	E	5.50	54.50	770.53		3.27		3.14
430257	11	C	2.83	49.38	486.68		4.00		3.51
430257	11	E	3.71	60.12	532.[illegible]		4.26		3.65
430258	50	C	1.70	25.19	500.89		3.08		2.59
430258	50	E	0.79	7.59	213.35		4.26		3.60
430260	22	C	3.33	19.51	726.24		7.44		6.34
430260	22	E	3.56	24.87	661.47		6.73		5.17
430263	4	C	3.67	24.66	598.75		4.19		3.66
430263	4	E	2.06	22.01	817.51		3.52		3.19
430264	4	C	4.49	20.26	595.60		4.03		3.44
430264	4	E	6.04	18.30	707.00		3.27		2.91
430256	25	C	3.03	49.08	709.64		3.73		3.00
430256	25	E	3.46	56.50	739.78		3.74		3.59
430261	22	C	3.23	24.45	664.99		7.54		6.42
430261	22	E	3.16	27.74	660.32		7.38		6.82
430266	22	C	3.03	19.18	686.70		6.80		6.06
430266	22	E	3.08	20.14	673.69		6.42		5.83

* CLI CL Instrument
** BMA Fairfax 001 CL Instrument

TABLE 2

MASS EQUIVALENT EMISSIONS PER TEST VEHICLE

CAR NO.	VID NO.	COLD HOT EVAP	HC MASS GM/ MI	CO MASS GM/MI	CO2 MASS GM/MI	NO* MASS GM/MI	NO*^ MASS GM/MI	NO* HUM GM/MI	NO** HUM GM/MI
430265	3	C	7.66	47.15	686.60		7.79		6.66
430265	3	E	7.66	49.46	641.57		7.56		6.10
430267	3	C	3.88	38.82	742.29		5.12		4.42
430267	3	E	4.51	42.00	758.88		4.88		4.42

* OLI CL Instrument
** EMA Fairfax 901 CL Instrument

APPENDIX A

CALIBRATION OF THE CONSTANT VOLUME SAMPLER

First Calibration data: February 12, 1971

Inlet Depression (PID) MM. Hg	CF/REV OBSERVED	CF/REV CALC.
39.0	0.3089	0.3005
48.5	0.3069	0.3015
56.5	0.3033	0.3012
63.0	0.3024	0.3003
70.0	0.3025	0.2986
75.5	0.3007	0.2968
81.0	0.2995	0.2945
89.0	0.2989	0.2903

Equation: CF/REV = .223711E-04PID**2*- .15243E-02PID* .32071E*00

Propane Check: Actual input grams = 52.97
Calculated input grams = 52.35

Second Calibration data: April 9, 1971 (results of calibrations run on February 12, 1971 combined with calibrations run on April 9, 1971)#

PID	CF/REV	CALC.
39.0	0.3089	0.3005
47.0	0.3023	0.3006
48.0	0.2977	0.3014
48.5	0.3069	0.3015
55.0	0.2957	0.3013
56.5	0.3033	0.3012
62.0	0.2937	0.3005
63.0	0.3024	0.3003
70.0	0.2898	0.2986
70.0	0.3025	0.2986
75.5	0.3007	0.2968
78.0	0.2881	0.2958
81.0	0.2995	0.2945
84.5	0.2868	0.2928
89.0	0.2989	0.2903

Equation: CF/REV = (-.80890E-04 * PID **2) + (0.35030E-02 *PID) + (0.282138 00)

(Used for calculating all the data).

APPENDIX B

CALIBRATION GAS STANDARD ANALYSED BY SIA USED FOR THE CONSTRUCTION OF CALIBRATION CURVES

Carbon Dioxide (CO_2)

Cyl. #	Analysis %
A 2547	0.80
A 2009	2.04
BL 33259	2.94
A 1933	4.01

Carbon Monoxide (CO)

Cyl. #	Analysis PPM
A 2225	992
A 454	1534
A 2228	2051
A 1369	3113

Hydrocarbons Propane in Air

Cyl. #	Analysis PPM Carbon
A 1562	27
A 976	54
A 1133	78
BL 26695	102
A 1406	150.6
A 675	205
944785	450

Nitric Oxide

Cyl. #	Analysis PPM
A 2478	49
A 2660	98
A 2122	162
A 2930	210
A 2419	549
A 2307	778
A 2615	1030

APPENDIX C

COMPARISON OF THE ANALYSES FOR NITROGEN DIOXIDE UTILIZING THE THERMAL CONVERTERS OF THE EPA, FAIRFAX AND FORD NOCD Vs. THE OLI INSTRUMENT (CL)

Cyl. #	Ford NOCD EvA Willow Run Terminal Building	Fairfax EPA Willow Run Building 2042	Fairfax OLI Test Facility	OLI CL	Date
	PPM	PPM	PPM	PPM	
A 2114	135				2-26-71
				150	3-1-71
	137	141		141	3-2-71
	132	132*	149	148	3-29-71
		141*	135		3-30-71
A 2373	223		215	241	3-3-71
		235	235		3-30-71
			235		3-29-71

* Values obtained from a second chemiluminescence instrument located at EPA, building 2042, Willow Run.

APPENDIX D-1

Olson Laboratories Inc.

22805 Michigan Ave., Dearborn, Mich. 48124

February 5, 1971

Dear 1971 Car Owner:

The U.S. Government needs your help to fight air pollution.

Because you recently purchased a 1971 car, you are already helping fight pollution. All the new cars are engineered to reduce the amount of pollutants emitted by the exhaust.

You may have heard about past work we have done for the Department of Health, Education & Welfare in testing levels of automotive emissions. Now the U.S. Government's new Environmental Protection Agency has taken over this responsibility. And they have asked us to perform a testing program to determine actual emission levels of typical consumer-owned 1971 model vehicles.

To do this we need to test your car for one day in February or March. In return for your cooperation we have been authorized to give you the following in return:

- **Payment of $5.00 for the test.**
- **Free tune-up if your car needs it (the test requires that all cars be tuned to factory specifications.)**
- **Free loan of a late-model car, fully insured and with a full tank of gas, while we make the test.**

We'll keep your car 24 hours or less, and will return it to you in the same or better condition. It will not leave our laboratory and will be tested under simulated normal driving conditions. It will be fully insured while in our laboratory.

Won't you help fight air pollution in this small way?

To participate, you must have at least 4,000 miles on your 1971 car at time of test. Just call Ed Stuart at 274-7060, or fill out and return the postage-paid card. We'll call you to arrange for a date most convenient for you.

Cordially,

Vice President

AIR POLLUTION CONTROL STARTS WITH MEASUREMENT

APPENDIX D-2

Olson Laboratories Inc.

22805 Michigan Ave., Dearborn, Mich. 48124

February 12, 1971

Dear 1971 Car Owner:

You can make an important contribution to the U.S. air clean-up program, and get a free engine tune-up in the process!

As you may have read, the U.S. Government's new Environmental Protection Agency has authorized a nation-wide testing program to determine the pollutants emitted by 1971 cars. Our company has been selected to perform the tests.

We would like to test your new car for one day in February or March. We have been authorized by the Environmental Protection Agency to give you the following in return:

- **Payment of $5.00 for the test.**
- **Free tune-up to factory specifications by Olson's automotive engineers, if necessary.**
- **Free loan of a late-model car, fully insured with a full tank of gas while we make the test.**

We will keep your car no more than 24 hours. It will remain in our laboratory during that period, and be tested under simulated normal driving conditions. It will be fully insured while in our laboratory.

To participate in this program which will eventually benefit everyone, you must have at least 4,000 miles on your car.

We know you'll want to be part of a project so critical to our future environment. For more information, just call Ed Stuart at 274-7060, or return the enclosed post-paid card. We'll contact you for a date most convenient to you.

Cordially,

Vice President

AIR POLLUTION CONTROL STARTS WITH MEASUREMENT

APPENDIX D-3

Olson Laboratories Inc.

22801 Michigan Ave., Dearborn, Mich. 48124

February 19, 1971

Dear 1971 Car Owner:

We're still hoping you want to join the fight against air pollution!

We wrote you recently about the major testing program now under way on 1971 cars. We have been selected by the U.S. Government's new Environmental Protection Agency to perform these tests.

Without data from your new car, and others like it, air clean-up could easily be delayed by several years.

All we need is the loan of your car for 24 hours. It will be fully insured while in our laboratory for testing under simulated normal driving conditions. We'll return it to you in the same or possibly *better* condition. Here is what you get in return:

- **A check for $6.00.**
- **Free tune-up if the car requires it. Even free points and/or spark plugs if required!**
- **Free loan of a late-model, fully insured car with a full tank of gas.**

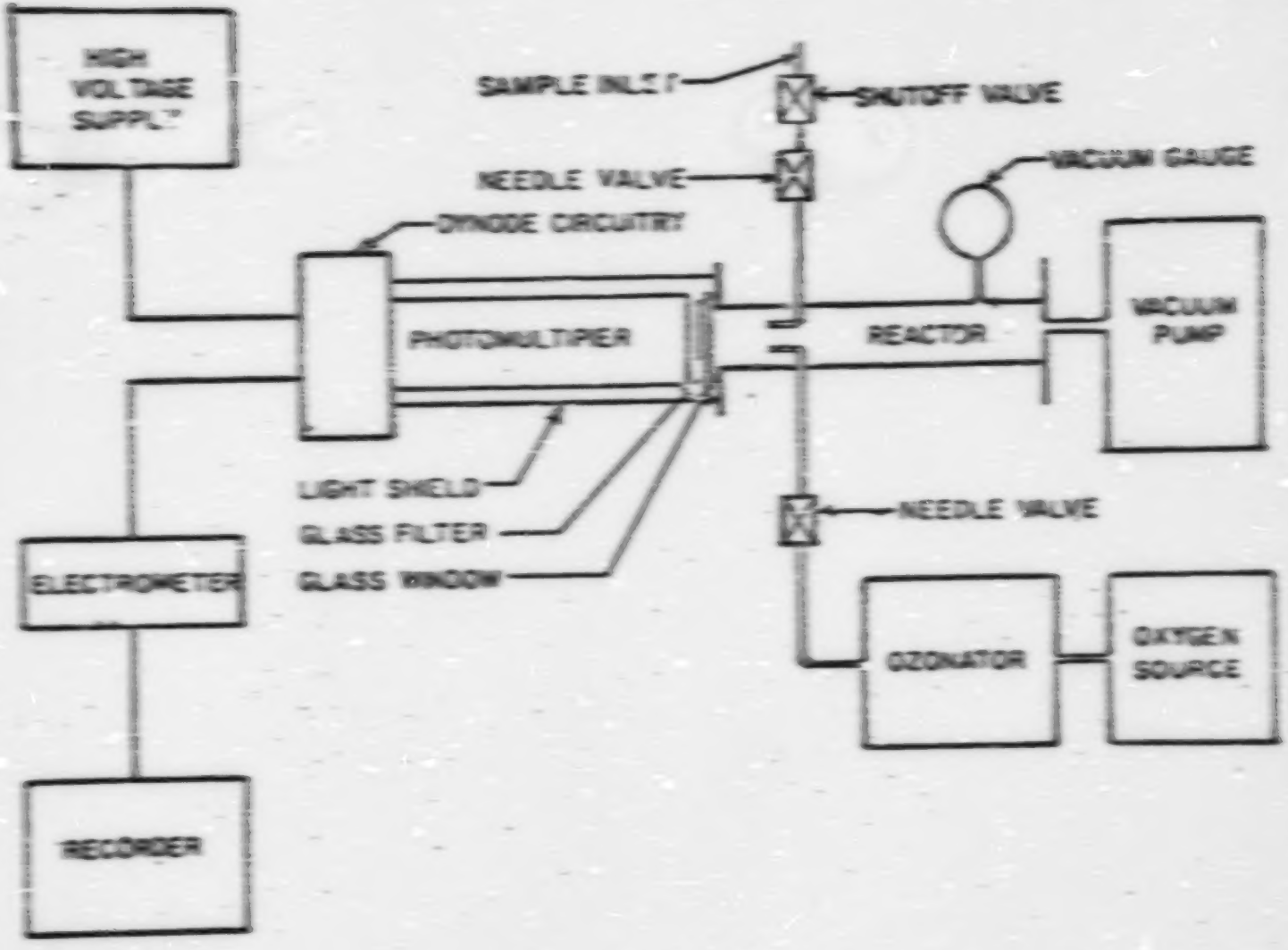
Perhaps you did not respond to our earlier letters because you had not driven the required 4,000 miles. If you have driven this distance now, or if you expect to reach that mileage level by April 1st, please fill out and return the enclosed card. Or call Ed Stuart at 274-7060 for more information.

You can really help fight air pollution!

Cordially,

Vice President

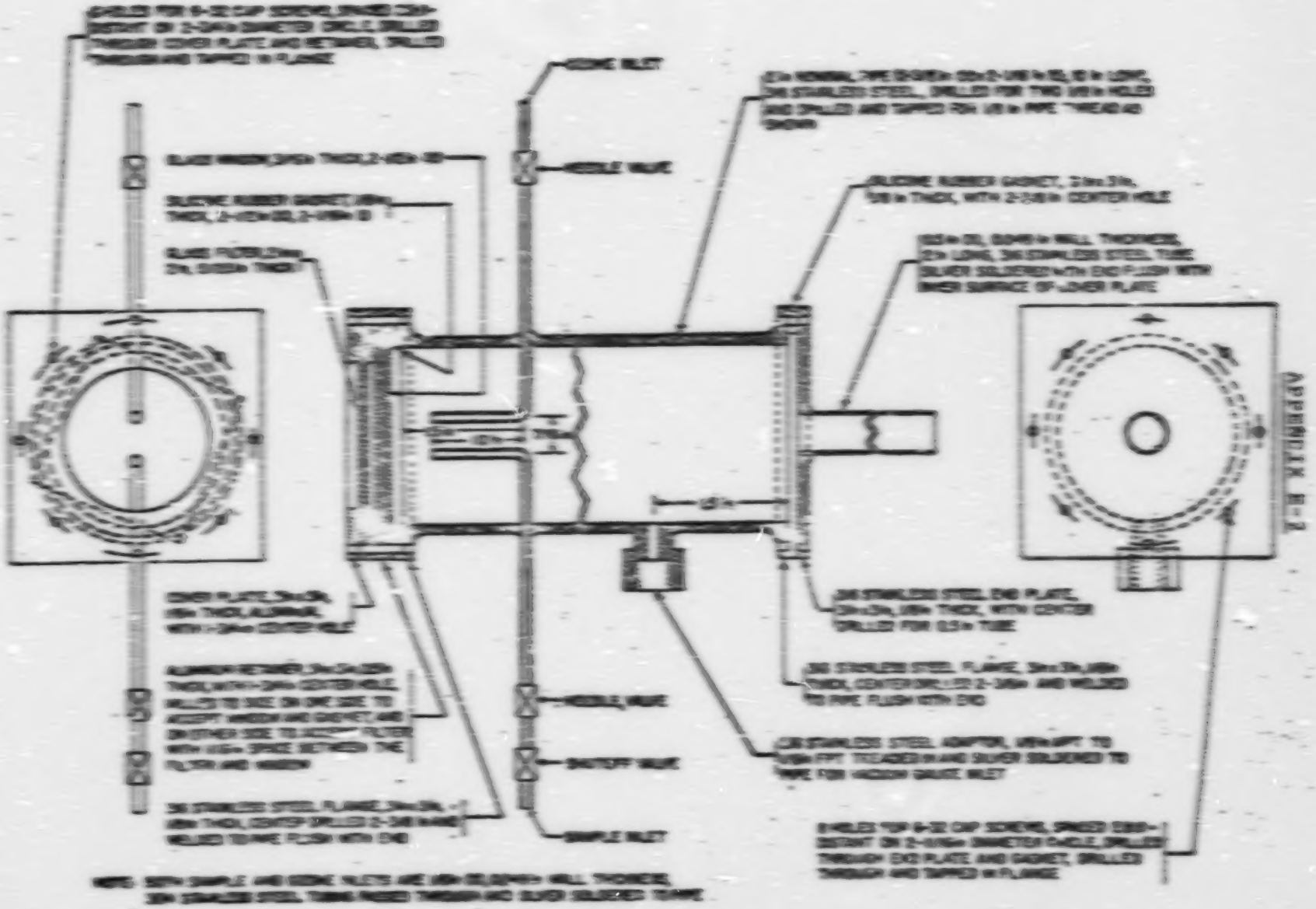
AIR POLLUTION CONTROL STARTS WITH MEASUREMENT



APPENDIX E-1

NITRIC OXIDE ANALYZER

FLOW SCHEMATIC



REACTOR

FLOW SCHEMATIC

APPENDIX B-2

TABLE II

LIST OF COMPONENTS REQUIRED
FOR
FABRICATION OF CHEMILUMINESCENCE SYSTEM

Purchase Order	Vendor	Item	Amount
5037	Allied Electronics	Photomultiplier Assembly	$ 411.24
4998	Will Scientific	Vacuum Pump Assembly	220.00
5043	AMES-GE Co.	Vacuum Gauge	125.00
5014	Copper & Brass Sales	Tubing	20.00
5013	Harris Calorific	Regulator	95.44
5012	Jones & Laughlin	Stainless Steel tubing	6.90
5011	H.E. Lennon, Inc.	Valves, Fittings & Tubing	174.70
5010	Applied Science	Silicone Rubber	45.00
5009	Michigan Valve & Fitting	Solenoid valves	43.00
4994	Jarce Research & Equip.	Ozonator	725.00
4993	Corning Optical Products	Filter	26.00
4992	Neptune	Pump	89.00
4991	Keithley Instruments	Picoammeter & Voltage Supply	788.09
5039	Service Steel	Stainless steel tubing	26.52
5048	Pacific Photometric Inst.	Photomultiplier Housing	295.00
Stock	Olson Laboratories	Cabinet	450.00
			$3,540.80
		Shipping (estimated)	50.00
		Total Cost of Materials	$3,590.80

APPENDIX B-3